

Space Weather Technical Forecast

Issued on Saturday 11 January 2025 at 01:10 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of isolated M-class flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low solar activity during the last 24 hours with only C-class flares, the peak a C9.9 flare at 10/2246 UTC originating from AR3947 in the northwest. There are ten sunspot regions visible on the Earth-facing disc. AR3947 remains the largest and most magnetically complex sunspot region, with a weak delta spot configuration forming. Recently numbered AR3956 in the northeast has shown some rapid growth with penumbra forming on both leading and trailing spots. The remaining regions on the disc remain small and simple at present.

Due to a lack of recent SOHO coronagraph imagery combined with large gaps in STEREO coronagraph imagery the detection of CMEs is more uncertain than usual. A possible filament eruption near the centre disc on 09 Jan may bring some enhancement at Earth, however this can not be correlated with coronagraph imagery at present.

Solar Wind / Geomagnetic Activity: Solar winds observed at L1 by ACE/DSCOVR have been slightly elevated for the majority of the period, around 430km/s, peaking at 490km/s at 10/1110 UTC. Initially average, density then fell to below average. The Interplanetary Magnetic Field, Bt, was largely weak, aside for a brief interval of moderate at the start of the period, peaking at 10nT at 10/0046 UTC. The north-south component, Bz, was weak and variable, ranging between -8nT and +7nT. The Phi angle was mainly positive (away from the Sun) with brief negative (towards the Sun) periods between 10/0850-1120 and again between 10/2100-2220 UTC. Geomagnetic activity was generally Quiet to Unsettled (Kp1-3) was some Active (Kp4) intervals between 10/0300-0600 and 10/2100-11/0000 UTC.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES-18 was at background levels. High energy electron flux (greater than 2MeV) at GOES16 was at background levels throughout. The associated 24 hour fluence remained below the Active threshold on a slight declining trend, reading 3.93e6 integrated pfu at 11/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate with an ongoing chance of isolated M-class flares.

Solar Wind / Geomagnetic Activity: A lack of SOHO coronagraph imagery and STEREO imagery means that CME analysis is difficult and comes with increased uncertainty. A possible filament

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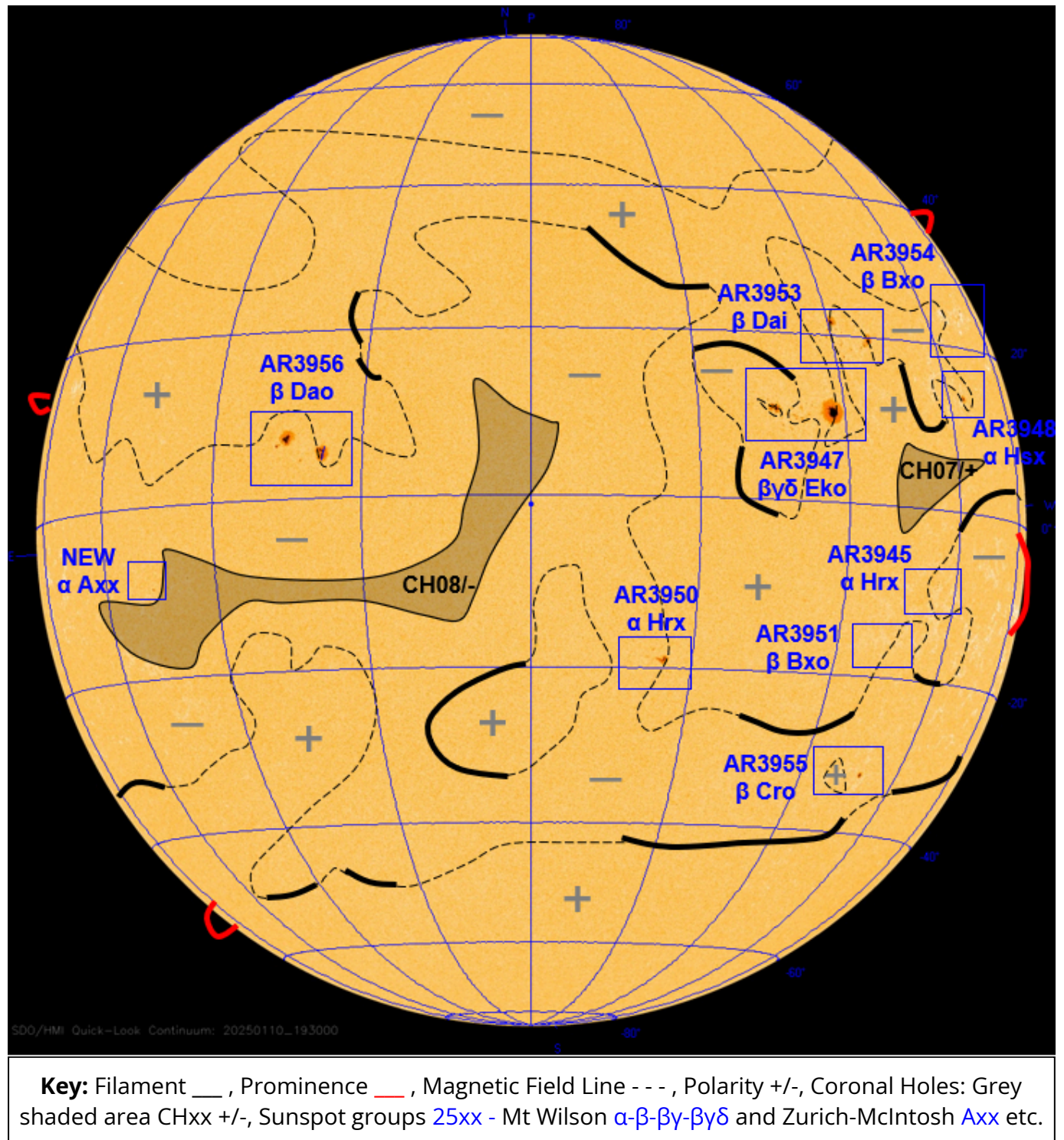
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eruption from near AR3947 on 09 Jan may bring some enhanced geomagnetic activity over the UTC weekend. Solar winds are currently slightly elevated, perhaps due to the onset of the high speed stream from CH07/+ which is expected to gradually wane by Day 2 (12 Jan). Fast winds from CH08/-, which is currently in the centre disc is then expected to bring some enhancement from Day 4 (14 Jan).

Geomagnetic activity is expected to be mostly Quiet to Unsettled with isolated Active intervals on Day 1 (11 Jan) due to any ongoing HSS influences. Any CME influence is likely to be rather dense, with a chance of G1 to G2 Minor/Moderate storms and a slight chance of G3 Strong Storm intervals possible through Days 1-3 (11-13 Jan), however this is very low confidence. By Day 4 (14 Jan) Unsettled geomagnetic activity is expected with Active intervals likely and a chance of G1 to G2 Minor/Moderate due to a connection to the fast winds from CH08/-.

Energetic Particles / Solar Radiation: GOES18 high energy proton flux is expected to remain near background levels, with only a slight chance of rising in response to any notable flares. GOES16 high energy electron flux is forecast to continue at Background to Moderate levels at first, perhaps rising to High through the forecast period. Electron fluence is not expected to reach Active thresholds at first, although a rising trend is possible later in the period.

Figure 1: Solar Synoptic Map valid 10/1930 UTC



Geomagnetic Storms

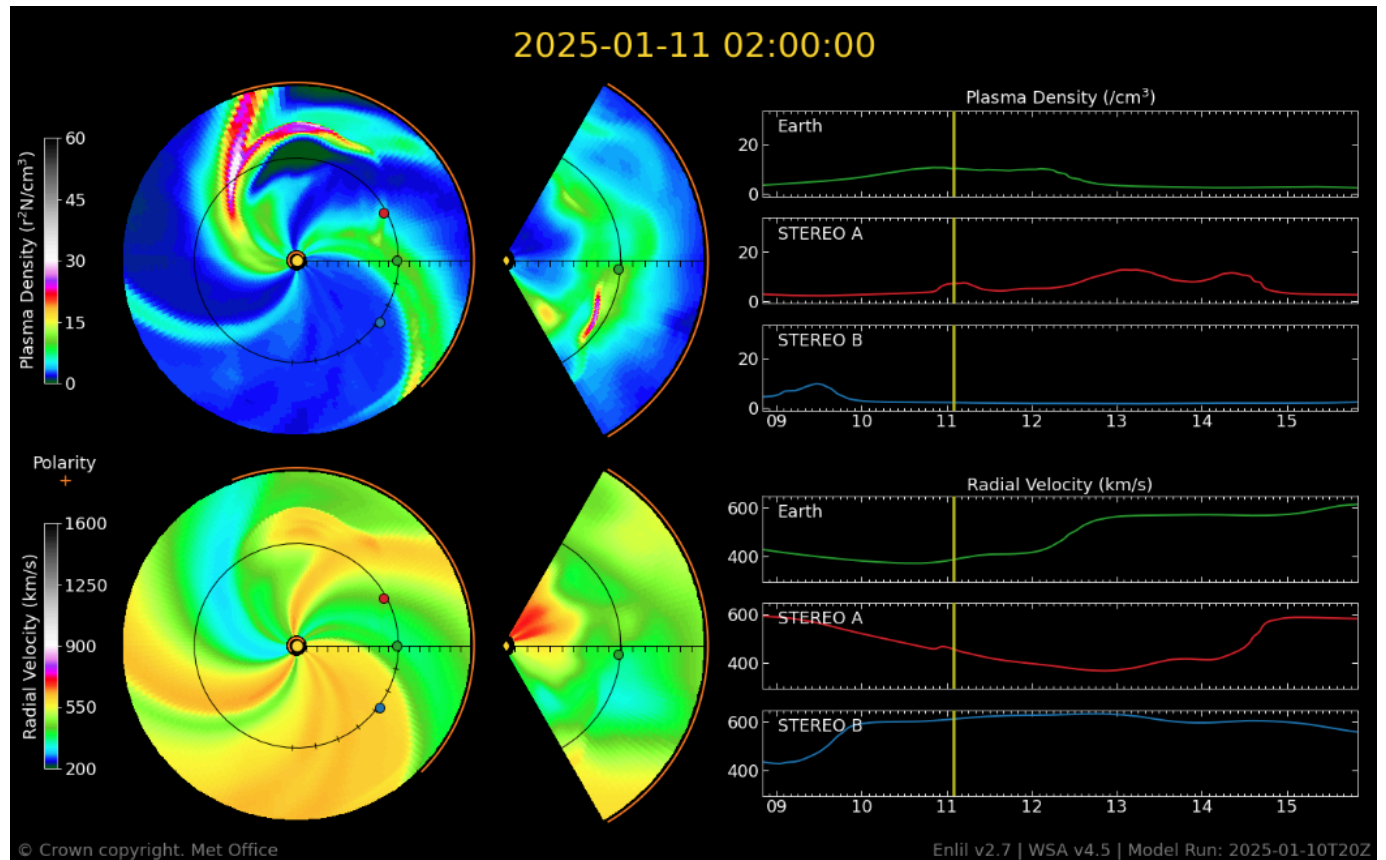
Solar winds are currently slightly elevated, most likely due to a connection to the fast winds from CH07/+ in the western hemisphere. This is a little earlier than originally expected, and whilst this feature appears small, it is partially obscured by flux lines in imagery. On the previous rotation wind speeds up to 450 km/s were observed, with similar speeds expected this time round, persisting through Day 1 (11 Jan) before slowly easing into Day 2 (12 Jan). CH08/-, currently in the eastern hemisphere, may begin to become geoeffective in the early hours (UTC) of Day 4 (14 Jan), this doesn't appear to be a reoccurring feature but the MOSWOC Enlil output is giving speed estimates of 600km/s. That being said, it is thought that Enlils onset of the fast winds from CH08/- is too early and viewed with moderate confidence.

A filament eruption to the northeast of AR3947 appears on SDO/AIA 304 imagery and GONG H-alpha around 09/1030 UTC with an associated long duration C-class flare. Given the continued lack of SOHO coronagraph imagery combined with large gaps in STEREO imagery its difficult to ascertain if any material was directed towards Earth as a result of this eruption. Given its location near centre disc, it is possible that we could see an Earth-directed component, but this is treated with significant uncertainty. Estimating a CME speed of between 500-1000km/s would bring impacts at Earth somewhere between late (UTC) on Day 1 (11 Jan) to the early hours Day 3 (13 Jan).

Geomagnetic activity is expected to be mostly Quiet to Unsettled with isolated Active intervals on Day 1 (11 Jan) due to any ongoing HSS influences. Any CME arrival is likely to be rather dense, given its filament origins, with a chance of G1 to G2 Minor/Moderate storms and a slight chance of G3 Strong Storm intervals possible through Days 1-3 (11-13 Jan), perhaps most likely on Day 2 (12 Jan), however this is very low confidence due to the rough estimates used in its analysis. By Day 4 (14 Jan) Unsettled geomagnetic activity is expected with Active intervals likely and a chance of G1 to G2 Minor/Moderate due to a connection to the fast winds from CH08/-.

Geomagnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	20	25	15	30
Strong	G3	No	5	10	5	5
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: MOSWOC Enlil output showing increasing solar winds from 12 Jan, however this is viewed as too early for the connection to CH08/-.



Radio Blackouts - X-Ray Flares

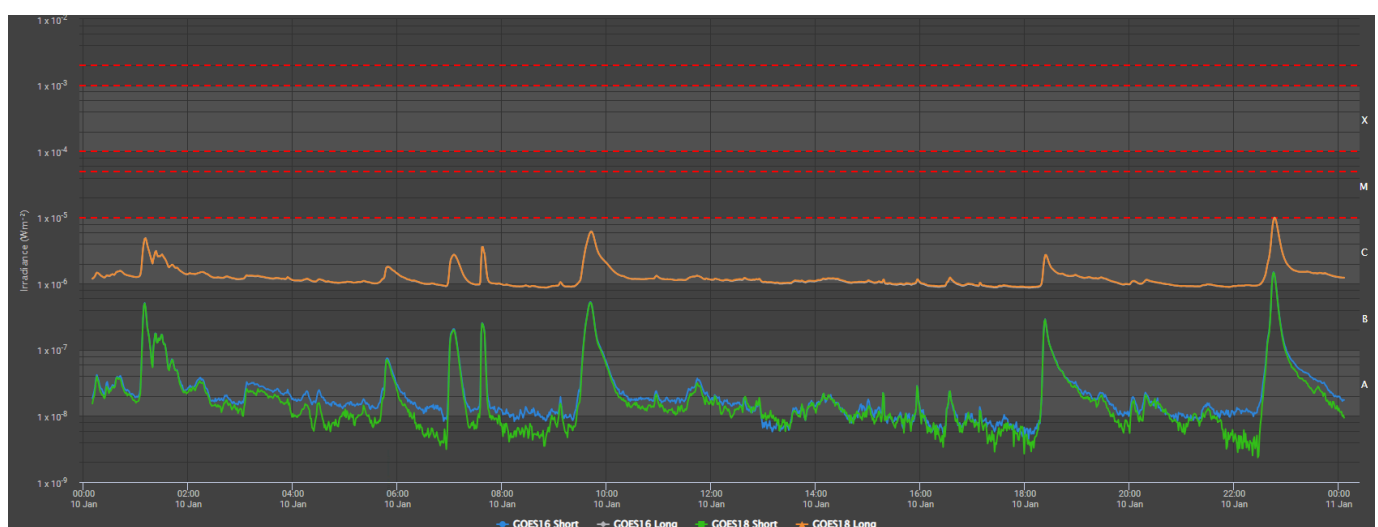
Low solar activity during the last 24 hours with only C-class flares, the largest a C9.9 flare at 10/2246 UTC originating from AR3947 in the northwest. There remains a chance of isolated M-class flares, primarily from AR3947.

There are ten sunspot regions on the visible disc with AR3947 remaining the largest and most magnetically complex. This region has been responsible for the majority of flare activity over the past few days, although has shown a drop in significant flares this past 48 hours. Following a filament eruption close to this region at 09/1100 UTC a weak delta spot has developed on its trailing portion, although in recent imagery some of the intermediate spots have shown some signs of decay. AR3953 in the northwest is the next largest region on the disc, although has produced no notable flares. AR3956 in the northwest is the region on the disc that has shown the most significant growth in the past 24 hours, with penumbra forming on its leading and trailing portions. The other regions on the disc remain small and simple at present.

A new region is starting to appear from around the northeast limb, with plage present on the magnetogram and evidence of looping in SDO 171 imagery.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	No	50	50	50	50
Very Active	R3-R5 (X Class)	No	10	10	10	10

Figure 3: GOES16 & 16 X-ray trace.



Solar Radiation Storms (High Energy Protons)

GOES18 high energy proton flux has remained at background over the last 24 hours. There is a slight chance of an enhancement as AR3947, the most complex spot, transits through the western hemisphere during the forecast period. This region has been the source of many M-class flares and isolated X-class flares, albeit with less in the way of significant flares recently. Furthermore, there are a number of filaments currently on the disc, and it is not impossible that a large eruption from any of these could result in Earth-directed high energy protons.

Radiation Storms	Level ($\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	15	15	15	15
Very Active	$\geq \text{S3}^*$	No	1	1	1	1
* $\text{S3} \geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and/or $50 \text{ MeV} \geq 10 \text{ pfu}$. ($\text{pfu} = \text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)						

High Energy Electrons ($\geq 2\text{MeV}$)

High energy electron flux observed at GOES16 has been at background levels over the past 24 hours. An early connection to the fast winds from CH07/+ appears to have suppressed the electron belts away from the location of GEO. As the solar wind speeds begin to ease over the coming days, we would expect the Van Allen belt to expand back to incorporate GEO and given the two recent fast wind events from an earlier connection to CH05/+ and now CH07/+ the electrons are likely to have been charged up. As a result we may see electron flux rise day on day, increasing to moderate, diurnally high levels. Complicating matters is the possibility of a CME from the 09 Jan filament eruption arriving over the UTC weekend, which could see the electron belts becoming suppressed again. Overall, it is probable that electron flux values will be at background to moderate levels at first. Without any CME influence the electron flux is likely to increase later in the period, with diurnal high peaks becoming more possible.

It looks unlikely that the Active threshold will be reached at first, but a rising trend is possible later in the period if the electron belts expand out once more and there is no CME influence observed. REFM seems a reasonable guide currently, perhaps not expressing the rising trend later in the period as suggested. Overall, this forecast is lower confidence than usual with the ongoing uncertainties in the Geomagnetic forecast.

GEO Electron Environment	Level ($\text{cm}^{-2}\text{sr}^{-1}\text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2\text{ MeV}$ $\geq 1\times 10^8$	No	10	20	30	40
Very Active	$\geq 2\text{ MeV}$ $\geq 1\times 10^9$	No	1	1	1	1

Figure 4: MOSWOC REFM output with a declining trend at first, rising again towards the end of the forecast period, but staying below the active threshold.

